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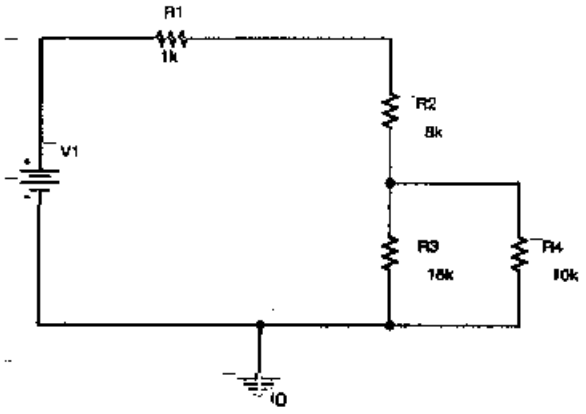
1. Resistive circuits (20 points)



In the circuit above, V1=15 volts.

a) (10 points) Find the amplitude of the voltage across R2.

$R_{34} = R_3 \| R_4 = \frac{15K\Omega \cdot 10K\Omega}{15K\Omega + 10K\Omega} = \frac{150}{25} K\Omega = 6K\Omega$ →

$V_{R_2} = \frac{R_2}{R_1 + R_2 + R_{34}} V_1 = \frac{8K\Omega}{1K\Omega + 8K\Omega + 6K\Omega} \times 15V \Rightarrow \boxed{V_{R_2} = 8V}$

b) (10 points) Find the current through R4.
Hint: First find the voltage across the combination of R3 and R4, then use the Ohm's law on R4.

$V_{R_{34}} = \frac{R_{34}}{R_1 + R_2 + R_{34}} V_1 = \frac{6K\Omega}{1K\Omega + 8K\Omega + 6K\Omega} \times 15V = 6V$

$V_{R_4} = V_{R_{34}}$

$I_{R_4} = \frac{V_{R_4}}{R_4} = \frac{6V}{} \Rightarrow \boxed{I_{R_4} = 0.6\ mA}$

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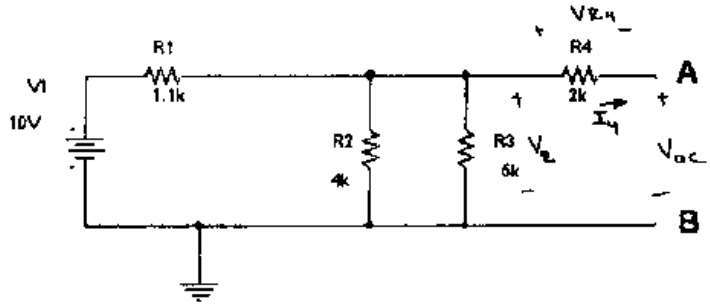
2. Thevenin circuits (20 points)

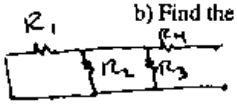


a) Find the Thevenin Voltage (Voc) (8 points)

$V_{oc} = V_2 - V_{R4}$, $V_{R4} = R_4 I_4 = 0$ $\Rightarrow$ $V_{oc} = V_2$ $\left\{ R_{23} = \frac{R_2 R_3}{R_2 + R_3} = 2.22\,k\Omega \right.$

$V_2 = \frac{R_{23}}{R_1 + R_{23}} V_1 = \frac{2.22\,k\Omega}{1.1\,k\Omega + 2.22\,k\Omega} 10V = 6.69\,V$ $\Rightarrow$ $\boxed{V_{th} = V_{oc} = 6.69\,V}$

b) Find the Thevenin Resistance (8 points)

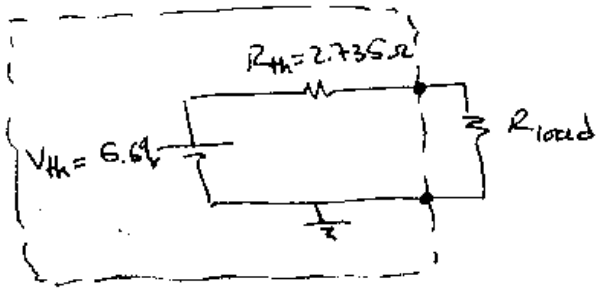


$R_{th} = R_4 + (R_1 \| R_{23}) = R_4 + \frac{2.22\,k\Omega \cdot 1.1\,k\Omega}{2.22\,k\Omega + 1.1\,k\Omega} = R_4 + 735\,\Omega$

$= 2k\Omega + 735\,\Omega$

$\Rightarrow$ $\boxed{R_{th} = 2.735\,k\Omega}$

c) Draw the Standard Thevenin Circuit, inserting the values you have found. (4 points)



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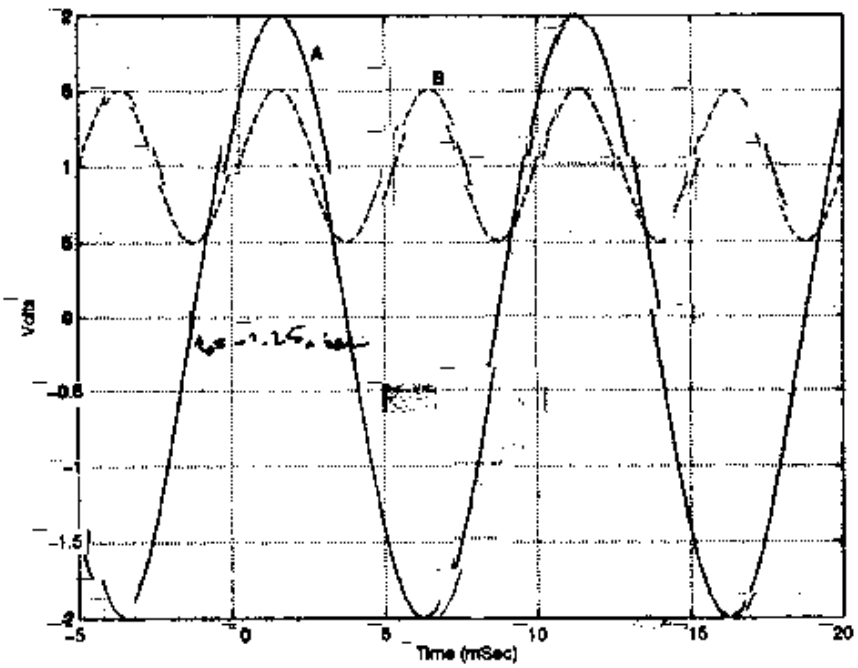
3. Sine Waves (20 points)



a) (6 points) Consider plot A in the above figure and give the following values:
(Do not forget the units):
Frequency = 100 Hz $T = 10\,mSec \Rightarrow f = 100\,Hz$
Amplitude = 2 V
RMS value = 1.414 V $V_{rms} = \frac{Amplitude}{\sqrt{2}}$
Peak-to-peak voltage = 4 V
Phase shift = $\pi/4$ $\phi = -\omega t_0 = -2\pi \times 100\ rad/s \times (-1.25\ ms) = \frac{1}{4}\pi$
Offset Voltage = 0

b) (4 points) Write down the mathematical expression for A as $V_A(t) = V_{off} + V\ Sin(\omega t + \phi)$

$$V_A(t) = 2_V\ Sin(2\pi \times 100\ t + \tfrac{\pi}{4})$$

c) (6 points) Now Consider plot B in the above figure and give the following values:
(Do not forget the units)
Frequency = 200 Hz
Amplitude = 0.5 V
RMS value = 0.353 V
Peak-to-peak voltage = 1 V
Phase shift = 0
Offset Voltage = 1 V

d) (4 points) Write down the mathematical expression for A as $V_A(t) = V_{off} + V\ Sin(\omega t + \phi)$

$$V_B(t) = 1_V + 0.5_V\ Sin(2\pi \times 200\ t)$$

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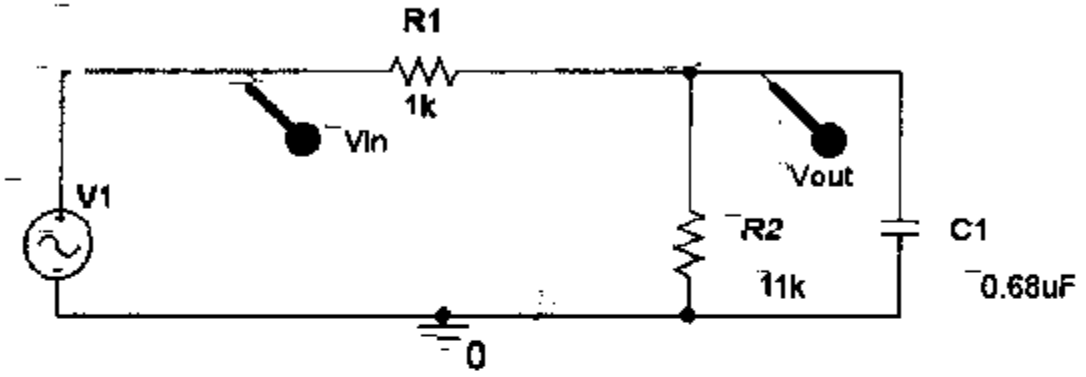
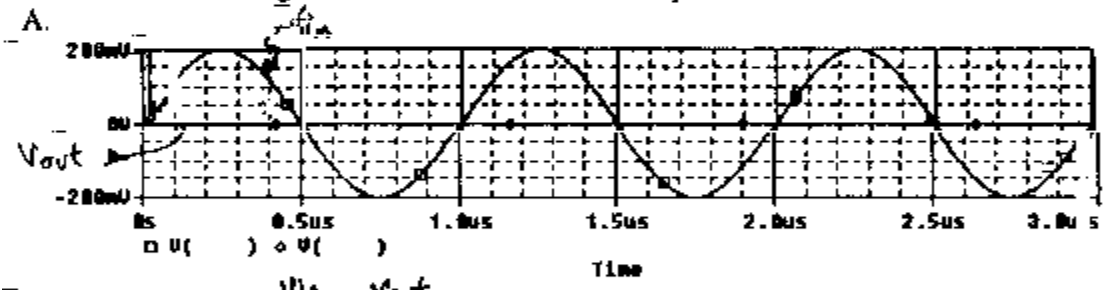
4. Simulation Results (20 points)

You have created the following circuit in Pspice:

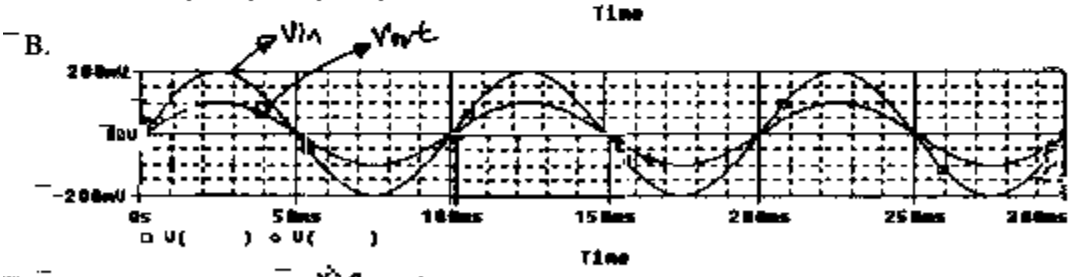


You run the following three transients at different frequencies:

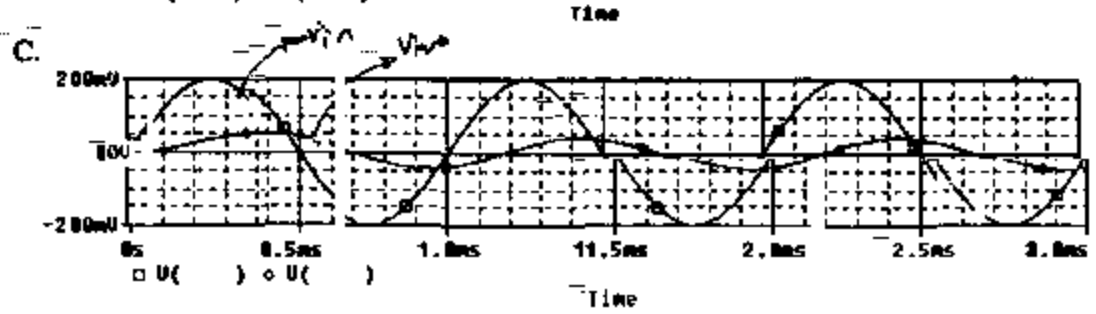
A.



B.



C.



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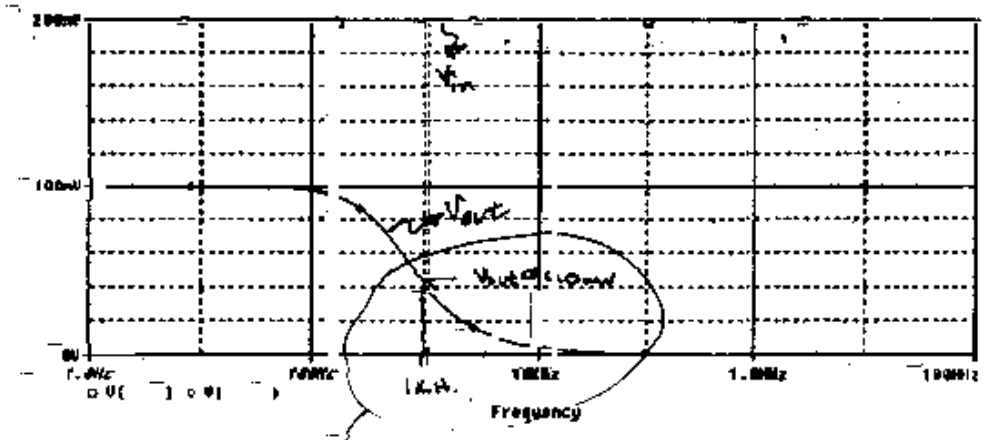
Next, you run an AC sweep and get the following results:



1. Identify the input voltage (V_{in}) and the output voltage (V_{out}) signals on the AC sweep plot and the three transient response plots: (7 points)

2. Which of the three transient plots (A, B or C) most likely represents the response at 1 kHz (5 points)

C

3. The above circuit best represents (pick one): (3 points)

a. high pass filter

b. low pass filter

Why? (5 points)

Since it passes low frequencies ($V_{out} \neq 0$ if f is small) but stops high frequencies ($V_{out} \approx 0$ if f is large).

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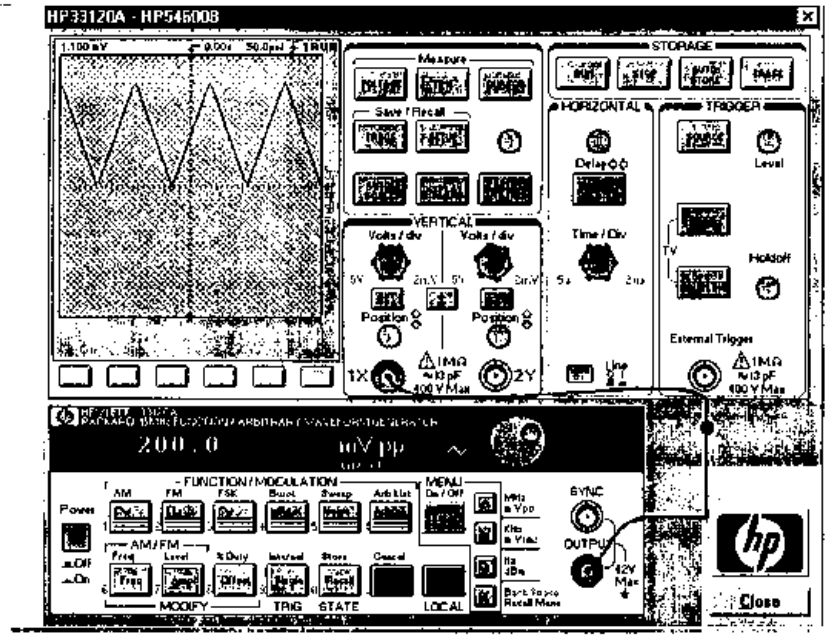
5) Instrumentation (20 points)



a) List two ways to obtain the frequency of the signal using the ocsilliscope (4 points)

1. Use the "Time" Button, then press "freq" 2(pts)

2. Use the display and find the period T, then $f = \frac{1}{T}$

b) When the function generator is connected to the scope you should notice a discrepancy between the reading on the display panel of the function generator, and the signal dsiplayed on the scope. What discrepancy do you see and which device is correct? (2 points) Why? (6 points) The discrepancy is that the Scope shows a signal twice that of the f.g. display. The scope is correct. This discrepancy occurs because the f.g. has 50 ohms internal and EXPECTS a 50 ohm load. The result would be a voltage divider of ½. Therefore the f.g. puts out 2.

c) Explain as simply as possible how to set up the function generator and scope to display the signal shown. (Use of Autoscale is NOT allowed). Give specific values. (8 points)

1. Press triangle wave button
2. Set offset to 100mV
3. Set Vpp to 200mV
4. Set frequency to 6.6kHz
5. Set scope to 100mV/div
6. Set scope to 50μs/div